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Dated 22 July 2004

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
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1. Your reference

STRAIN GAGE

2. Patent application number
(The Patent Office will fill in this part)

0316403.5

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

ZEROSHIFT Ltd
The Coplan Building
Michigan Drive, Tongwell.
Milton Keynes MK15 8HQ

Patents ADP number *(if you know it)*

8669301001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

Method for Sensing Torque in a Transmission System.

5. Name of your agent *(if you have one)*

N/A

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

As above

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6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
N/A		

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

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N/A	

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	None
Description	4
Claim (s)	None
Abstract	None
Drawing (s)	None

10. If you are also filing any of the following, state how many against each item.

Priority documents	None
Translations of priority documents	None
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	None
Request for preliminary examination and search *(Patents Form 9/77)*	None
Request for substantive examination *(Patents Form 10/77)*	None
Any other documents *(please specify)*	None

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 10th July 03

12. Name and daytime telephone number of person to contact in the United Kingdom Bill Martin 01908 617 469

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Notes

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Method for Sensing Torque in a Transmission System

The present invention relates to a method for measuring torque in a transmission system. More particularly, the present invention is intended to facilitate torque sensing using a strain gauge on multi-speed transmissions.

Although this invention is applicable to many applications, the following description focuses on automotive automatic transmissions.

Fluctuations in driveline torque during gear shifts result in fluctuations in acceleration of the vehicle during the shift.

Shift quality (the feel of the shift) can be controlled by an accelerometer. The drivetrain control system reacts to vehicle acceleration or deceleration caused by the shift thus minimising discomfort to the occupants during rapid shifts.

A better way of achieving smooth shifts is to sense and control torque in the driveline. Thus corrections can be made before vehicle acceleration or deceleration due to the shift, occur.

In automotive automatic transmission systems, torque measurement or calculation of torque in the output shaft is made prior to a shift. Torque is controlled to minimise fluctuations during the shift so that the shift feels smooth.

Conventional measurement of torque by measuring the rotational deformation (twist) of a shaft under torque load is expensive and problematic. The connection of wiring to a rotational body requires slip rings, magnetic sensing, or wireless transmission of data. Another conventional method is to calculate the torque based on other parameters such as input power and rpm. This method can be inaccurate.

It is possible to measure torque by placing a strain or pressure gage in or near a shaft bearing. This measures the force between the shafts, which is directly proportional to the torque transferred. A curve could be generated such that a strain reading would correlate to a torque figure. The problem here is that this

applies only to a single gear ratio. A shift in ratios would result in an entirely new curve due to the change in RPM and the new position of the forces at the new gear location along the shaft length.

This invention is for the application of a strain gage to measure torque in a multi ratio transmission in order to control shift quality.

In accordance with the present invention there is provided a method for measuring output torque where power is transmitted from one shaft to another, or others, in a transmission with at least two ratios by measuring the strain or pressure set up between the shafts and their mounting points or the casing, due to the torque transmitted.

Furthermore to achieve the above to a degree where it may be applied to the control of shift quality in an automotive transmission system.

The transmission of power from one shaft to another always sets up a load force on the shafts other than pure rotational forces. For example teeth in mesh tends to force shafts apart. Pulleys and belts or chains tend to pull shafts together. Helical cut gears cause axial loads. These non-rotational forces vary proportional to the torque being transmitted.

By fitting a strain or pressure gauge such as a D.C. wheatstone bridge type, to an appropriate position on or near a shaft bearing mounting or transmission casing, it is possible to detect changes in torque. This can be calibrated to match the torque figures, possibly with the use of a conventional toque sensor for calibration only.

In an automotive transmission a torque reading is taken prior to the shift. Clutch and throttle settings are controlled during the shift so as to control the torque level throughout the shift. This in turn controls shift quality.

As the strain gauge is not fitted to a rotating shaft, readings are accurate, instantaneous and reliable.

There are however, several problems associated with getting this to work in practice. The position along the axial length of the shaft determines the pressure exerted upon the bearing. For the data from the strain gage to be meaningful it is necessary for the system to know which gear ratio is engaged so that the correct multiplier or curve to be applied to the reading to compensate for the variation in distance from the bearing to the gear on each ratio.

Ideally the shift strategy would not include a period where power is transmitted through two ratios simultaneously during the shift such as in a conventional planetary automatic or a dual clutch automated manual. Preferably the system would be fitted to a system, which had clearly defined ratios with a single clutch.

A further limitation would be where the shift strategy involved the use of a direct drive ratio. Direct drive eliminates the transfer of power from one shaft to another hence no torque reading can be made in the direct drive ratio.

Fortunately direct drive ratios tend to be top or near to top gear where vehicle speeds are higher and vehicle acceleration is reduced. Thus shift quality is naturally good. Generally the up-shift from 1st gear to 2nd gear is the most abrupt and in need of a rapid response control system as disclosed herein.

One embodiment would be possible to apply a strain gage to the differential. No multipliers or curves would be required as merely minimising fluctuations in the reading would control shift quality. The compromise would be that the response would be slower than taking readings at the transmission due to twist wind up in the drive shaft between the differential and the transmission, particularly in rear wheel drive vehicles. Rear wheel drive is prevalent in the luxury car market where shift quality is critical.

A further embodiment would be to fit strain gages to the transmission and the differential where the strain gage on the differential controls direct drive ratio shifts only.

Yet another embodiment is for the strain gage or gages, and driveline control system above to be used for traction control to save money.

The step of adjusting the torque of the engine (throttle position) may be achieved by direct alteration of the throttle position. This may involve temporarily overriding driver input.

The correct multiplier settings for the strain gauge to suit each ratio may be calibrated by the temporary fitting of a torque sensor. This would only need to be done once for each vehicle configuration.

Planetary gear configurations could use the same principle although the strain on the casing would be a more equal expansion of all the planetary shafts rather than a linear expansion between two shafts.

Modifications and variations such as would be apparent to the skilled addressee are considered to fall within the scope of the present invention.